PATENT ABSTRACTS OF JAPAN

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(21)Application number : 09-327961 (71)Applicant : MINOLTA CO LTD

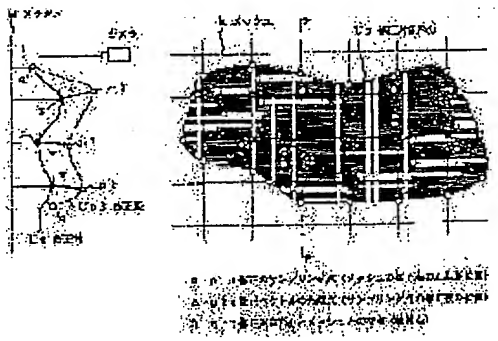
(22)Date of filing : 28.11.1997 (72)Inventor : BAN SHINICHI

(54) THREE-DIMENSIONAL FORM DATA PROCESSOR AND MODELING SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To generate a model whose feature on the sight of an object is reflected on a form and whose appearance is natural by specifying a part which requires correction based on two-dimensional photographing information of the object and generating the form model which is locally emphasized.

SOLUTION: A data processor eytracts the area of a specified face element from a two-dimensional picture which color picture data shows. Eyebrows and pupils in the three-dimensional form model specified by form data are set to correction object parts Up and they are deformed, for example. In deformation, a mesh M vertical to a camera eye is projected on the correction object part and a correction vector (v) is calculated with a position on which a lattice point is projected as a sampling point (p). Then, the intersections (q) of the mesh M and the outlines of the correction object parts Up are obtained and a curve surface passing through the tip positions p2 of the correction vector (v) and the outline points (q) is obtained. The curve surface and the original three-dimensional form model are synthesized and the correction object parts Up are substituted for the obtained curve surface Up2. Thus, the positions of the pupils and the eyebrows are expressed by the forms.



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CLAIMS

[Claim(s)]
[Claim 1] The three-dimension configuration data processor for the model creation characterized by adding the data correction which deforms the part corresponding to the description field which extracted the description field which fills setups and was extracted from the two-dimensional image which photoed the body to the geometric model of the body concerned obtained by the non-contact three-dimension measurement to said body.
[Claim 2] The three-dimension configuration data processor for the model creation characterized by adding the data correction which transforms the two-dimensional image which carried out color photography of the body according to the color information corresponding to each field of said two-dimensional image which divided according to the color condition and was divided to the geometric model of the body concerned obtained by the non-contact three-dimension measurement to said body which corresponds to it for every part.
[Claim 3] The modeling system for the model creation characterized by having the three-dimension configuration data processor according to claim 1 or 2 which adds data correction to the geometric model of said body obtained by said three-dimension metering device based on the two-dimensional image of said body obtained by the photo-electric-conversion equipment which photos a body, the three-dimension metering device which measures the configuration of said body by non-contact, and said photo-electric-conversion equipment.
[Claim 4] The modeling system according to claim 3 by which the change with the mode of operation which adds said data correction, and the mode of operation which is not added was constituted possible.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]
[Field of the Invention] This invention relates to three-dimension configuration data processing for creating the model of the body which exists.

[0002]
[Description of the Prior Art] The non-contact type three-dimension metering device (three-dimension camera) of a portable mold is commercialized, and it is used for the visual recognition of the data input to CG system or a CAD system, a somatometry, and a robot etc. As the non-contact measurement approach, although slit light projection (optical cutting method) is common, otherwise, pattern light projection, the stereo ** method, the interference fringe method, etc. are learned.

[0003] Moreover, available three-dimension CG software and the small three-dimension cutting machine for hobbies are marketed with the personal computer. If these are used, a model and a creation object can be manufactured easily also at ordinary homes.

[0004] On the other hand, a kind of automatic vending machine which creates a user's photograph-of-his-face seal on that spot is collecting popularity. A user throws in the coin for a tariff, and he makes a favorite pose in front of a camera, looking at monitor display. And if predetermined actuation is performed, the sheet with which a fixed number of seals were located in a line will be created, and it will be discharged by output port. From most models, two or more alternative is prepared about a configuration, a counterpart lump pattern, etc. of a photograph of his face.

[0005]
[Problem(s) to be Solved by the Invention] According to the above-mentioned three-dimension metering device, the configuration of the various bodies which contain the body by handiness comparable as taking a photograph can be data-ized. Since it is a non-contact type, even if it is the case where the body is measured, a measurement candidate does not sense troublesomeness. Then, it is possible to use this three-dimension metering device for creation of a ****** model, if it is a photograph of his face. That is, if it combines with a three-dimension processing machine, it is possible to measure a person's face and to create the model of a suitable scale factor on that spot.

[0006] However, in non-contact three-dimension measurement, the element of the face which is not geometrically distinguished from others will not appear in a model. For example, although the so-called iris-of-the-eye part of the eyeballs is an important element by which a face is characterized, it is not distinguished from a pewter part. The eyebrows drawn with makeup tools will also be assimilated to a frame.

[0007] Moreover, this he may have sense of incongruity in the model which reproduced boom hoisting of a face faithfully. This is because color influences the consciousness of boom hoisting as the twist of the lip of a warm color system can also actually rise and be seen. Even if a configuration is faithful, a non-colored model will look flat compared with the familiar face.

[0008] This invention aims at enabling creation of the natural model of the appearance which the description on objective vision reflected in the configuration.

[0009]
[Means for Solving the Problem] In this invention, the required part of correction is specified based on the two-dimensional photography information on objective, and the geometric model emphasized locally is generated.
[0010] The equipment concerning invention of claim 1 is a three-dimension configuration data processor for model creation, and adds the correction which emphasizes the part corresponding to the description field which extracted the description field which fills setups and was extracted from the two-dimensional image which photoed the body to the geometric model of the body concerned obtained by the non-contact three-dimension measurement to said body.
[0011] The three-dimension configuration data processor concerning invention of claim 2 adds the data correction which transforms the two-dimensional image which carried out color photography of the body according to the color information corresponding to each field of said two-dimensional image which divided according to the color condition and was divided to the geometric model of the body concerned obtained by the non-contact three-dimension measurement to said body which corresponds to it for every part.
[0012] The modeling system concerning invention of claim 3 is equipped with the three-dimension configuration data processor which adds data correction to the geometric model of said body obtained by said three-dimension metering device based on the two-dimensional image of said body obtained by the photo-electric-conversion equipment which photos a body, the three-dimension metering device which measures the configuration of said body by non-contact, and said photo-electric-conversion equipment.
[0013] The change with the mode of operation to which the modeling system concerning invention of claim 4 adds said data correction, and the mode of operation which is not added is constituted possible.
[0014]
[Embodiment of the Invention] Drawing 1 is the external view of the three-dimensional-model listing device 1 concerning this invention. The three-dimensional-model listing device 1 measures a body configuration, has the function to process a material on that spot based on the measurement data, and is used as an automatic vending machine of the accessories article which modeled a user's face. The goods created are the stereos with which the model of the face projected from the plate surface of a predetermined configuration (for example, square). It is also possible to add a specific boom-hoisting pattern to a plate surface (a part for a background). If the suitable metallic ornaments for such goods are attached, it will become accessories, such as a pendant, a broach, and a key holder. Metallic ornaments may be beforehand attached in a material.
[0015] The floodlighting aperture 12 and the light-receiving aperture 14 for optical three-dimension measurement are prepared in the front face of the almost life-size Johan section of a case 10 with the display 16 for a user to check a pause. The light-receiving aperture 14 is used also for two-dimensional color photography. The bottom half section of a case 10 is jutted out over the front side rather than the Johan section, and the top face serves as a control panel 18. The output port 20 of goods is established in the front face of the bottom half section.
[0016] A user stands toward the three-dimensional-model listing device 1, and throws in the coin for a tariff. If a user performs start actuation after that, the three-dimensional-model listing device 1 will display the three-dimension geometric model (for example, surface model) which shows a measurement result while measuring the configuration of the body which exists within the limits of [fixed] a transverse plane. And if a user performs confirmation operation which directs the decision of composition, the three-dimensional-model listing device 1 will start three-dimension processing according to a measurement result. Goods are completed by the time amount for about several minutes. A user takes out goods from output port 20.
[0017] Drawing 2 is the top view of a control panel 18. The input port 185 of a start button 181, a confirmation button 182, Cancel button 183, a joy stick 184, and a coin is established in the control panel 18. A start button 181 is a start actuation means, and a confirmation button 182 is a confirmation operation means. A joy stick 184 is used for modification directions of the composition of a model. In

response to the Pan actuation leaned to right and left, the tilt actuation leaned up and down, and roll actuation of rotating a knob, rotation processing of a three-dimension geometric model is performed, and a processing result is displayed on serial. Moreover, Cancel button 183 is an actuation means for directing re-measurement, when the three-dimension geometric model as which the user was displayed is not pleasing. However, the count of effective is set to Cancel button 183, and re-measurement cannot be directed without any restriction.

[0018] Drawing 3 is the functional block diagram of the three-dimensional-model listing device 1. The three-dimensional-model listing device 1 consists of modeling system 1A which generates the three-dimension geometric model of model size, and processing system 1B which actualizes a three-dimension geometric model.

[0019] Modeling system 1A contains the photography system 30 which changes into digital data appearance information of the user who is an original body (data-izing). The photography system 30 consists of the three-dimension metering device 34 which data-izes configuration information by slit light projection, two-dimensional photography equipment 36 which data-izes color information, and a controller 38. In addition, it may replace with slit light projection and other technique may be used for three-dimension measurement. The color picture data DC which are the photography information by the configuration data DS which are the measurement information by the three-dimension metering device 34, and two-dimensional photography equipment 36 are inputted into a data processor 40. Since the relative relation of the camera coordinate of three-dimension measurement and two-dimensional photography is known, it is easy to carry out alignment of the three-dimension geometric model based on the configuration data DS and the two-dimensional photography image. The data processor 40 is equipped with the image-processing circuit which is not illustrated, and performs various kinds of data processing including data correction peculiar to this invention. The controller 42 of a data processor 40 also bears overall control of the three-dimensional-model listing device 1, and gives the suitable directions for the controller 38 of the photography system 30, and the controller 76 of processing system 1B. A display 16 and the actuation input system 80 are connected to this controller 42. The actuation input system 80 consists of an above-mentioned control panel 18 and an above-mentioned tariff receipt device.

[0020] On the other hand, processing system 1B is equipped with the processing equipment 72 which cuts ingredients, such as a resin block, the ingredient feeder 74 which performs supply in the processing location of an ingredient, and conveyance to the output port 20 of a workpiece, the controller 76, and the output port sensor 78. The detecting signal of the output port sensor 78 is inputted into a controller 42.

[0021] In addition, a controller 42 may be made to take charge of control of the photography system 30 and processing system 1B, and the circuitry which omitted the controller 38 and the controller 76 may be adopted.

[0022] Drawing 4 is the perspective view showing an example of the device configuration of processing system 1B. The ingredient feeder 74 has the stock section 210 which contains the ingredient of a total of eight sorts of configurations. Storage space is established in the both sides of the straight-line-like migration way 212, and the elevator 220 is arranged four pieces at a time along the migration way 212 in the storage space of each **. Two or more ingredients of the same class are accumulated on each elevator 220, and vertical migration control of an elevator 220 is performed so that the best ingredient may be located in predetermined height. If one kind of ingredient suitable for the model which it is going to create is specified, the specified ingredient will extrude as a work piece 216, and will be sent out from storage space with a rod 218 on the migration way 212. And the work piece 216 on the migration way 212 is sent into the table 200 of processing equipment 72 with the migration rod 214 with a chuck.

[0023] In a table 200, a work piece 216 is fixed with two stoppers 202 and clamp fixtures 204. And it is cut with the cutter 208 attached in the upper and lower sides, right and left, and order at the movable revolving shaft 206.

[0024] After three-dimension processing is completed, a work piece 216 is pinched by the chuck at the tip of the migration rod 214, is carried to the edge by the side of discharge of the migration way 212, and

is sent into an exhaust port 222. It may not be based on the migration rod 214, but a work piece 216 may be moved to an exhaust port 222 from a table 200 in a sliding way format.
[0025] The device configuration of processing system 1B is not restricted to instantiation. For example, if an elevator is horizontally arranged [ingredient / of the same class] at the end of the array direction on each multistage shelf and an ingredient is extruded in an elevator from a shelf, the number of elevators can be reduced. You may also carry a work piece to a stowed position -> processing location -> discharge location with an arm robot. It is also possible to replace with cutting and to create a model by technique, such as the laminating molding method (for the Mitsuzo form method to be included), laser processing (thermoforming), and molding processings (pressurization etc.). Moreover, about an ingredient configuration, a user may enable it to choose a favorite appearance and may be made to make automatic selection of that to which floor to floor time becomes the shortest from two or more sorts of ingredients which made the model of a standard face beforehand.
[0026] In the three-dimensional-model listing device 1 of the above configuration, in order to create the natural face model of appearance, the data correction which transforms automatically the three-dimension geometric model obtained by three-dimension measurement using the color photography information on the face is made by the data processor 40.
[0027] Drawing 5 is the mimetic diagram of partial data correction. A data processor 40 extracts the field of a specific face element from the two-dimensional image which the color picture data DC express first. Let eyebrows and the iris of the eye (the iris and pupil) be the objects of an extract with this operation gestalt. An extract is performed in the following ways. ** Divide a two-dimensional image into the field of a same color phase by clustering in a specific color space (for example, L* a* b* color space). ** the result -- receiving -- labeling -- carrying out -- a same color phase -- and extract the continuous field. ** Match using the template beforehand created based on the statistics about the location and color of a face element, and select the field equivalent to eyebrows and the iris of the eye.
[0028] Next, the eyebrows of the three-dimension geometric models specified by the configuration data DS and a dark-eyed part are set as the part Up for correction, and moderate deformation is performed. Deformation is performed in the following ways. ** Set to sampling point p the location where the mesh M perpendicular to a camera look was projected to the part Up for correction, and the lattice point of the mesh M in the part Up for correction was projected. ** Calculate the correction vector v of perpendicular setting die length to a model side toward a camera side with sampling point p as the starting point. The die length of the correction vector v is set up about each of eyebrows and the iris of the eye. For example, the eyebrows are longer. ** Ask for the intersection (this is called profile point) q of Mesh M and the profile of the part Up for correction. ** Search for the curved surface which passes along the location (tip point) p2 at the tip of the correction vector v, and the profile point q. ** Compound the curved surface searched for and the original three-dimension geometric model. That is, it transposes to the curved surface Up2 which asked for the part Up for correction of the three-dimension geometric models. By this, the part Up for correction will rise and a dark-eyed location will be expressed by the configuration. The same is said of the eyebrows drawn with the eyebrow pencil. Since the location of the profile point q does not change, the continuity of a field is maintained between eyebrows and the irises of the eyes, and those perimeters.
[0029] Hereafter, actuation of the three-dimensional-model listing device 1 is explained using a flow chart. Drawing 6 is the Maine flow chart which shows actuation of an outline. After a power source is switched on, in the waiting period which waits for actuation by the user, two-dimensional photography and the display of a photography result are repeated (#10, #12, #14). Moreover, a guidance message is displayed periodically. If a tariff is injected and a start button 181 is pushed, while performing two-dimensional photography anew, three-dimension measurement will be performed (#16, #18). Predetermined data processing is performed (#20) and the obtained three-dimension geometric model is displayed (#22). At this time, appearance is raised with the application of the well-known graphic technique of attaching a shadow. And it waits for directions actuation. However, the latency time is limited, and if it passes over the time limit, it will be considered that it is that to which confirmation operation was performed.

[0030] If a joy stick 184 is operated, a three-dimension geometric model will be rotated according to actuation as mentioned above, and it will display (#24, #38). If Cancel button 183 is pushed, it will return to actuation of a waiting period (#40, #10). However, re-measurement will be performed, if a user does not need to inject a tariff anew and pushes a start button 181 in this case.
[0031] A push on a confirmation button 182 generates the data for processing control with reference to a processing condition database based on a three-dimension geometric model (#28). (#26) An ingredient is processed (#30). After processing finishes, goods are discharged (#32), and it checks that goods have been taken out by the output port sensor 78, and returns to standby actuation (#34, #10).
[0032] Drawing 7 is a flow chart which shows the contents of data processing of drawing 6 . Here, the next processing including the data correction partially upheaved as mentioned above and compaction of floor to floor time, or compression of the depth direction for intentional flattening on a design is performed.
[0033] While performing data smoothing and removing the abnormality data based on a noise, it avoids that excess reappears to fine irregularity (#200). Re-sampling processing is performed (#210). This is processing changed into the data which aligned by the lattice point of spacing, such as having carried out parallel projection from a certain direction, in order to make the right pair of the input data carry out in the processing direction, when the face has turned to slant. For example, when the bottom of the lug of people's face becomes shade and cannot measure, after wearing a face upward and carrying out three-dimension measurement, data are convertible so that the face which turned to the usual transverse plane may be expressed. When there is no measure point in the location where the lattice point was projected, the measurement value of the perimeter performs a linearity complement. At this time, it becomes the vertical upper part at the time of the projected direction processing it, and each lattice point has data of height. Moreover, even when input data is based on a perspective projection, input data can be changed into parallel projection data by this processing.
[0034] A deficit part without data is complemented (#220). As the complement technique, various technique, such as a linearity complement and weighting ****, is applicable. For example, all the parts into which data are missing are replaced with a fixed value (simple complement). As the fixed value, the average of the set point, the minimum height, and the periphery location of a face can be considered. When the deficit section is completely surrounded in the effective-data part, a linearity complement is carried out from surrounding data. Moreover, if it is in the part which can expect that exact data are not obtained from the target property by optical three-dimension measurement like the black eyebrows in people's face, or hair just, you may replace with the existing three-dimension configuration data. In this case, the standard model of the face (first half side of a head) is prepared, and the data of the standard model which adjusted a location and size are used about a data deficit part. The following procedure performs adjustment of a standard model. Both eyes and opening are extracted from a two-dimensional image in the same way as the case of the data correction mentioned above, and the location of three reference points is calculated. And line type conversion of a standard model is carried out so that each origin/datum of a standard model may be in agreement with the geometric model of an observation. In addition, such composition is applicable to the part of not only the deficit part of a face but arbitration.
[0035] After obtaining a three-dimension geometric model faithful to an object configuration by each above processing, data correction peculiar to this invention which actualizes eyebrows and the iris of the eye as mentioned above is made (#230). In addition, emphasis which heaps up particular parts, such as a lip and a cheek, a little may be performed at this time. Moreover, when performing whether data correction is made, it is also possible to prepare a mode change function so that a user or a device-management person can choose which part (element of a face) is corrected.
[0036] Height compression processing is performed and the dimension of a three-dimension geometric model is contracted in the depth direction (#240). That is, the difference of elevation of the depth direction is made small, and floor to floor time is shortened. Moreover, for the application of a pendant or a medal, a superficial model is suitable. To compression, both of the technique, uniform compression and un-uniform compression, can be applied, and it can also use properly for every part to it.
[0037] A part for the background of the three-dimension geometric models is detected (#250). This is

pretreatment for correcting a part for a background. A user's tooth back is considered as the blue back, and if the result of color distinction of a two-dimensional image is used, detection for a background will become easily and certain.

[0038] Background conversion transposed to other data about a part for a background is performed (#260). For example, since depth is extremely deep, a part for a background is changed into data with shallow depth in order to shorten floor to floor time. The solid side data which express patterns and geometric patterns, such as flowering trees and shrubs, also by flat-surface data are sufficient as the data to replace.

[0039] Size adjustment in which a full-scale three-dimension geometric model is fitted to goods size is performed (#270). Moreover, resolution conversion in which the amount of data is fitted to the precision of processing equipment 72 is performed (#280). Although this processing projects the mesh of predetermined grid width of face and it re-samples in the lattice point, the direction to project is being fixed in the direction of a vertical at the time of processing. As the point of resolution conversion (the number conversion of data), first, the pitch between points and ** KUTORU variation define the configuration point group of the geometric model for processing, and the pitch range between points corresponding to ** KUTORU variation is read from the property data table memorized beforehand, and is set up. That is, data are thinned out, a pitch is enlarged, or data are interpolated and a pitch is made small. What is necessary is only just to cull out, when the resolution of measurement is large enough. If the resolution conversion function is prepared, since the resolution of the three-dimension metering device 34 will not be limited, the use gestalt of exchanging a measurement means according to an application will be permitted.

[0040] Alignment to which the parallel displacement of the zero of a coordinate is carried out so that the criteria location of a three-dimension geometric model may suit the last in the criteria location of processing is performed (#290). In addition, when using the ingredient with which predetermined irregularity was made above beforehand on the occasion of processing, in the processing data generation processing (#28 of drawing 6) in response to confirmation operation, the amount of cutting is computed by comparing the three-dimension geometric model obtained by the above processing with the irregularity made.

[0041] Drawing 8 is a flow chart which shows the contents of partial data correction processing of drawing 7 . As drawing 5 explained, eyebrows and the iris of the eye are first extracted from a two-dimensional image (#2310). The part Up for correction is set up to a three-dimension geometric model (#2320), Mesh M is projected, and the correction vector v is calculated (#2340). Moreover, it asks for the profile of the part Up for correction, and the intersection (profile point) q with Mesh M. About the part Up for correction, and the profile point q, you may ask for whichever first, and the operation which asks for them can also be performed in parallel.

[0042] And a field including the tip point p2 of the correction vector v and the profile point q is searched for as a correction partial model (#2360), and the field searched for and the original three-dimension geometric model are compounded (#2370).

[0043] In an above-mentioned operation gestalt, the field of a specific color is extracted from a two-dimensional image, and although the example which upheaves the model side corresponding to the field was given, the correction according to objective color may be added in the way of ** of a degree - ** for the whole three-dimension geometric model.

** Recarry out the map of the luminance signal of a two-dimensional image to the Munsell color space.

** Decide which shaft orientations are made into a parameter among Hue (hue), Value (lightness), and Chroma (saturation).

** Set up the zero used as the criteria of correction, a forward (outside) direction, and a scale factor.

** Cluster as an image processing to a two-dimensional image with the parameter decided by **, carry out labeling, and divide a two-dimensional image according to a cluster (field division).

** Match each divided field with the front face of a three-dimension geometric model.

** Like an above-mentioned operation gestalt, Mesh M is projected, define a sampling point, calculate the correction vector v, and make a model side transform. At this time, the direction and magnitude of

the correction vector v are computed based on the HVC value of the corresponding field.
[0044] Although the three-dimensional-model listing device 1 supposing the use as an automatic vending machine was illustrated with the above-mentioned operation gestalt, it does not ask whether data processing concerning this invention is whether model creation is onerous and onerous. Not only contraction size but actual size or expansion size is sufficient as the size of a model. The living things or inanimate objects other than a person are sufficient as an original body.
[0045]
[Effect of the Invention] According to invention of claim 1 thru/or claim 4, the natural model of the appearance which made the description on objective vision reflect in a configuration can be created.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the external view of the three-dimensional-model listing device concerning this invention.
[Drawing 2] It is the top view of a control panel.
[Drawing 3] It is the functional block diagram of a three-dimensional-model listing device.
[Drawing 4] It is the perspective view showing an example of the device configuration of a processing system.
[Drawing 5] It is the mimetic diagram of partial data correction.
[Drawing 6] It is the Maine flow chart which shows actuation of an outline.
[Drawing 7] It is the flow chart which shows the contents of data processing of drawing 6 .
[Drawing 8] It is the flow chart which shows the contents of partial data correction processing of drawing 7 .
[Description of Notations]
40 Data Processor (Three-Dimension Configuration Data Processor)
1A Modeling system
36 Two-dimensional Photography Equipment (Photo-Electric-Conversion Equipment)
34 Three-Dimension Metering Device
DC Color picture data (two-dimensional image)
DS Configuration data (geometric model)
Up Part for correction (part corresponding to the description field)

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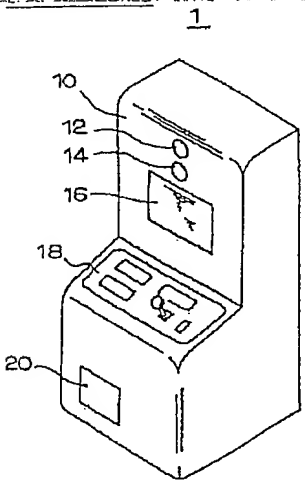
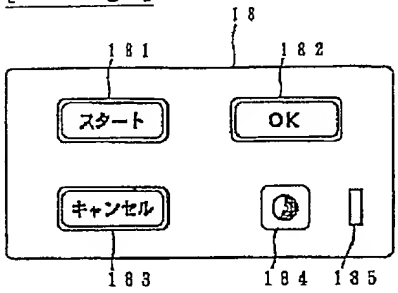
DRAWINGS

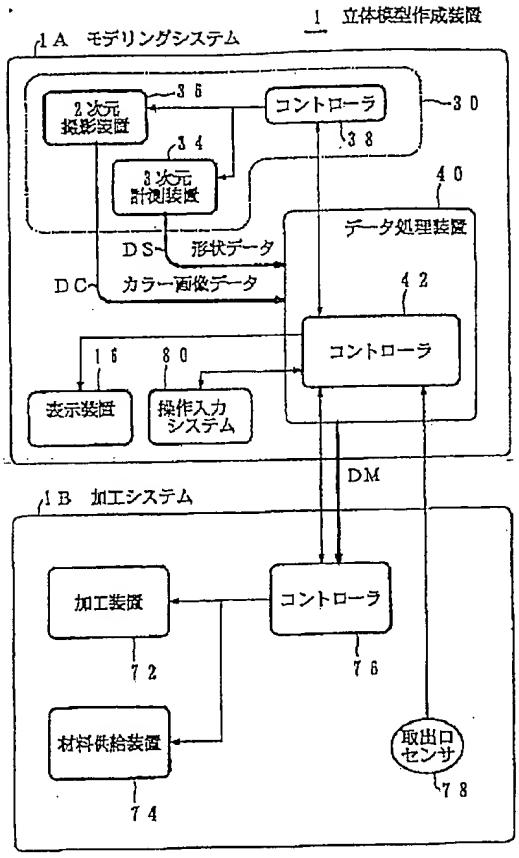
[Drawing 1]



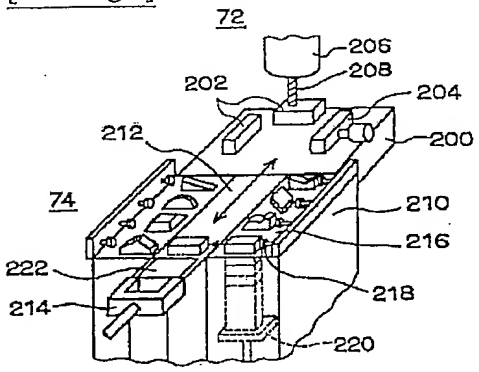
[Drawing 2]



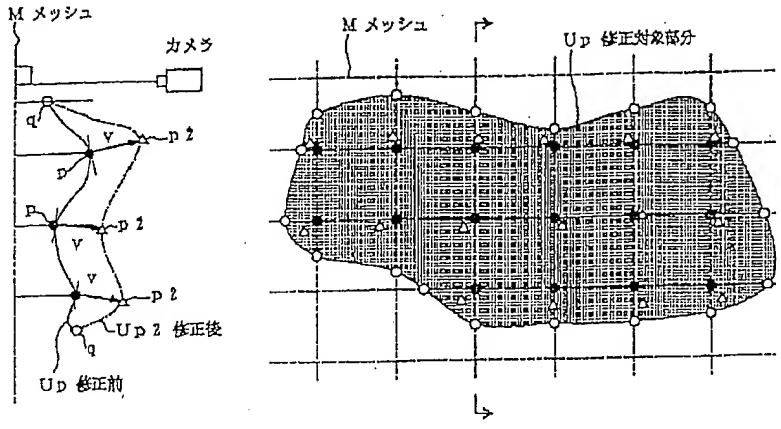
[Drawing 3]



[Drawing 4]



[Drawing 5]

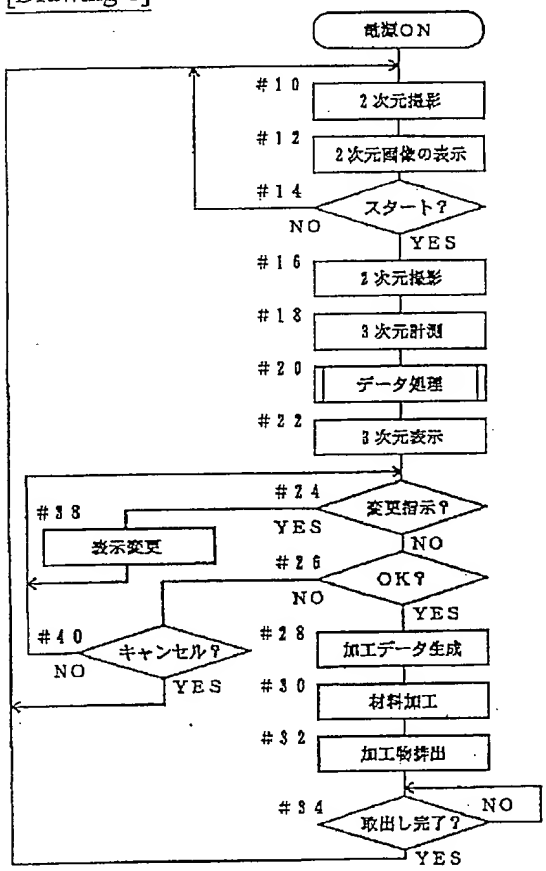


● p ：修正のサンプリング点（メッシュの格子点の正投影位置）

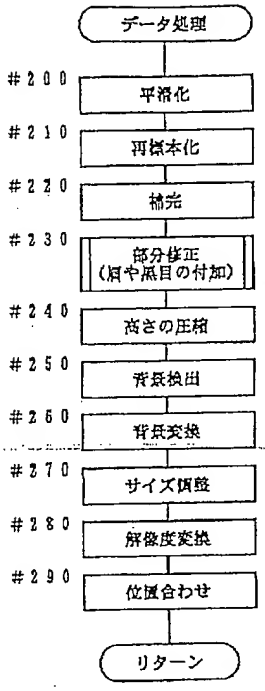
△ p 2：修正ベクトルの先端点（サンプリング点の修正後の位置）

○ q ：修正対象部分とメッシュとの交点（検索点）

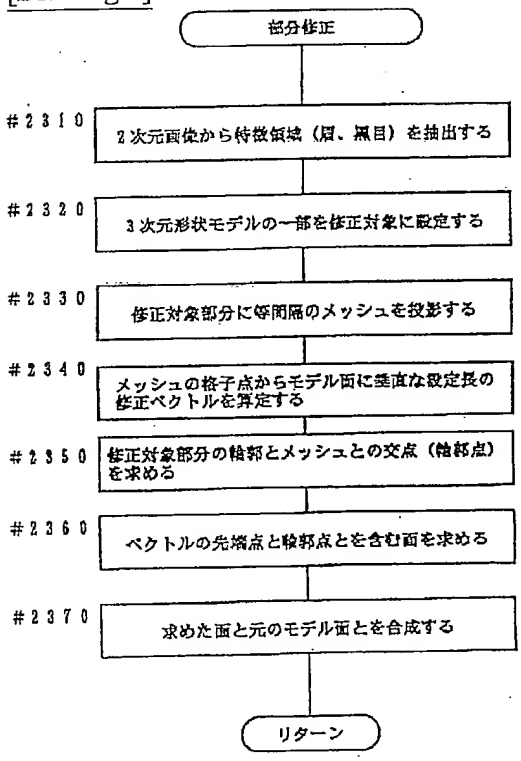
[Drawing 6]



[Drawing 7]



[Drawing 8]



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